Direct and Inverse Heat/Mass Diffusion Problems in Li-ion Batteries and Drug Delivery Devices

Ankur Jain

Associate Professor, Mechanical and Aerospace Engineering Department
The University of Texas at Arlington, Arlington, TX 76019
Email: jaina@uta.edu; Ph: 817-272-9338
Web: www.uta.edu/mtl

Abstract

Heat/mass diffusion plays a key role in determining the efficiency, reliability and safety of a variety of engineering systems including Li-ion cells and drug delivery devices. For example, Li-ion cells suffer from several thermal safety problems, as evidenced by recent incidents of fires in electric cars and aircraft. As another example, optimization of mass transport in drug delivery devices such as stents may help improve their therapeutic effectiveness. Understanding and optimizing the nature of both direct and inverse heat/mass diffusion problems in such systems is, therefore, of much importance.

This talk will discuss a few interesting direct and inverse heat/mass diffusion problems that occur in Li-ion batteries and in drug delivery devices. Experimental measurements and simulations that investigate the fundamental nature of thermal conduction within a Li-ion battery will be discussed. Theoretical analysis of multilayer diffusion-reaction problems for predicting thermal runaway in Li-ion cells will be discussed. Key outcomes of this analysis include derivation of a new non-dimensional number and multiple but finite number of imaginary eigenvalues in such problems. Finally, an inverse mass transfer problem occurring in multilayer drug delivery will be discussed. It will be shown that careful optimization of initial drug distribution in the device based on inverse mass transfer theory can help obtain desirable drug delivery profiles. These results may help meet individualized drug delivery needs of patients by combining advanced manufacturing with mathematical optimization.